

**CORPS OF ENGINEERS
KANSAS CITY DISTRICT OFFICE**

**ENERGY ENGINEERING
ANALYSIS PROGRAM (EEAP)
BOILER AND CHILLER PLANTS
FORT LEONARD WOOD, MISSOURI**

Contract No. DACA41-86-C-0015

FINAL SUBMITTAL

EXECUTIVE SUMMARY

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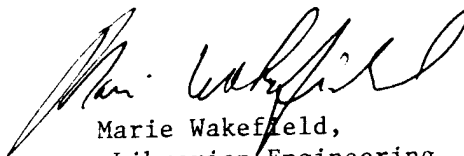
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**KANSAS CITY DISTRICT OFFICE - CORPS OF ENGINEERS
ENERGY ENGINEERING ANALYSIS PROGRAM
FORT LEONARD WOOD, MISSOURI
BOILER/CHILLER PLANTS**

**Final Submittal, 12/88
Detailed Instructions to Update
Executive Summary**

1. Replace the green title sheet.
 2. Replace page i, Table of Contents.
 3. Replace page 1, Introduction.
 4. Replace page 2, Acknowledgment.
 5. Replace page 3, Table I.
 6. Replace pages 4, 5, 6 and 7, Table II
 7. Insert page 8, Ft. Leonard Wood Map.
 8. Insert pages 9, 10, 11, 12 and 13, Table III.
 9. Insert page 14, Table IV.
 10. Remove pages 8 through 17 and insert pages 15 through 24, Annual Energy Savings.
 11. Remove pages A-2 through A-8 and replace them with pages A-2 through A-8, LCCA Summary Sheets.
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I. EXECUTIVE SUMMARY

A. INTRODUCTION

Lutz, Daily & Brain Consulting Engineers was commissioned by the United States Army Corps of Engineers (COE) to develop an Energy Engineering Analysis Program (EEAP) of the Fort Leonard Wood Boiler and Chiller Plants. The EEAP consists of several phases including but not limited to data collection, data refinement, on-site inspection, concept development, performance testing, preparation of programming documents, and documentation of alternatives and recommendations. The Scope of Work (SOW) of this Contract has been modified to include the use of propane instead of No. 6 fuel oil for the feasible Energy Conservation Opportunities (ECO) calculations. This fuel change was analyzed because the Base has initiated a program of switching from No. 6 fuel oil to liquid propane for all of their boiler plants. The results of all ECO calculations using No. 6 fuel oil have been included at the request of the COE for record purposes. Nonfeasible ECO's were not rerun for propane, because changing the fuel from No. 6 fuel oil to propane, a higher cost fuel, would not make the ECO's feasible. This submittal presents finding of the EEAP and provides recommendations for implementation.

1. In detail this report presents the following information:

Determine the efficiency of the boiler/chiller plants by appropriate tests.

Survey the boiler/chiller plants to determine if the efficiency can be improved by the repair, addition, or modification of equipment and recommend improvements.

Evaluate the control system and recommend changes, repairs, or new controls which will improve the efficiency of the plants.

Review operation and maintenance procedures and provide site specific recommendations which will increase the efficiency of the plants to the maximum level.

Prepare programming and implementation documents.

Prepare a comprehensive report to document the work performed, the results, and recommendations.

List all Energy Conservation Opportunities (ECO) and perform complete evaluations, including low cost/no cost items.

Tabulate project documentation for Military Construction Projects (DD Form 1391) and Project Development Brochure (PDB).

List implementation documentation for all justifiable energy conservation opportunities.

List and priorities for all recommended energy conservation projects.

2. Implementation of the measures outlined herein will result in substantial improvement in operations cost of the Fort Leonard Wood Boiler and Chiller Plants. Modifications to the Boiler and Chiller Plants identified within the study include:

- Direct digital chiller controls.
- Flue gas monitoring and oxygen trim.
- Burner and burner controls replacement.
- Installation of economizers.
- Replacement of chillers.

3. Acknowledgements

Lutz, Daily & Brain wishes to acknowledge the cooperation of Ms. Christine Hendzlik, Project Manager, Mr. Jack DeShurly, the Point of Contact at Fort Leonard Wood and numerous other boiler/chiller plant personnel.

4. The study is organized into the following eight volumes plus an Executive Summary and Programming and Implementation Documentation.

<u>Volume</u>	<u>Description</u>
--	Executive Summary
--	Programming and Implementation Documentation
1	Summary
2	Building 311 Boilers
3	Building 645 Boilers
4	Building 745 Boilers
5	Building 1021 Hot Water Generator Units
6	Building 2351 Boilers
7	Building 2369 Hot Water Generator Units
8	Chillers

5. Energy Conservation Opportunities' Descriptions and Packaging

Table I is a list of the project types prioritized by SIR. The grouping of the ECOs into each of these projects is as requested by Mr. Jack DeShurley. All of the feasible ECOs prioritized by Savings to Investment Ratio (SIR) are listed in Table II. Table II also lists the Simple Amortization Period (SAP) and the Estimated Replacement Cost. Table III lists the locations, capacities and other information on the equipment involved in this report. Table IV lists possible percent energy savings by building if feasible ECOs are implemented. Figure Nos. 1, 2, 3, 4, 5 and 6 are graphical representations of the estimated annual energy savings for the feasible ECOs. Appendix A of this summary includes the backup calculations for the data that is presented in Table II.

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TABLE I

BOILER/CHILLER PLANTS PROJECT PACKAGING

<u>Project Type</u>	<u>ECO Nos.</u>	<u>Estimated Cost</u>	<u>Average SIR</u>	<u>Average SAP</u>	<u>Description</u>
ECIP	7P,9P, 10P,11P, 15P,18P	\$490,000	2.65	6.40	Boilers-Burner & Burner Controls
ECIP	14P,16P, 17P,20P	\$333,000	2.00	7.53	Boilers-Economizers
ECIP	21,22,23	\$784,040	1.82	6.51	Chillers-Replacement
QRIP	1,6,4,12	\$133,000	6.35	1.59	Chillers - Direct Digital Control to Operate Chillers and Auxiliaries
Low Cost/No Cost (LC/NC)	2P	\$ 3,400	6.28	2.72	Flue Gas Analyzer
LC/NC	3P,5P,8P, 13P,24P	\$ 98,325	3.26	5.23	Boilers - Flue Gas Monitoring and Oxygen Trim
LC/NC	19P	\$ 19,665	2.63	6.50	Boilers - Flue Gas Monitoring and Oxygen Trim

Refer to Table II for additional description of ECOs.

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TABLE II

FEASIBLE ENERGY CONSERVATION OPPORTUNITIES (ECO)
(These evaluations are based on Propane Fuel
and 1,110 Hours of Chiller Operation)

ECO	Description	SAP	SIR	Estimated Replacement Cost
1.	Bldg 1021 - Direct Digital Controls	1.08	9.28	\$18,000
6.*	Bldg 311 - Direct Digital Controls	1.24	8.09	\$45,000
2P.	Portable flue gas analyzer	2.72	6.24	\$ 3,400
4.	Bldg 2369 - Direct Digital Controls	2.08	4.83	\$35,000
3P.	Bldg 745, Blr No. 1 - Flue gas monitoring equipment and oxygen trim in conjunction w/burner replacement	3.90	4.34	\$19,700
5P.	Bldg 645, Blr No. 3 - Flue gas monitoring equipment and oxygen trim in conjunction w/burner replacement	4.09	4.14	\$19,700
12.	Bldg 745-Direct Digital Controls	2.50	4.00	\$35,000
8P.	Bldg 1021, HW Generators A&B - Flue gas monitoring equipment and oxygen trim in conjunction w/burner replacement	6.96	2.44	\$ 39,400
7P.	Bldg 645, Blr No. 3 - Burner and burner controls	4.87	3.48	\$74,000
9P.	Bldg 745, Blr No. 1 - Burner and burner controls	5.29	3.20	\$79,000
10P.	Bldg 745, Blr No. 5 - Burner and burner controls	5.39	3.15	\$79,000
11P.	Bldg 745, Blr No. 4 - Burner and burner controls	5.41	3.13	\$79,000

*Based on 4,000 hours operation at request of installation.

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TABLE II (Continued)

ENERGY CONSERVATION OPPORTUNITIES (ECO)
(These evaluations are based on Propane Fuel
and 1,110 Hours of Chiller Operation)

ECO	Description	SAP	SIR	Estimated Replacement Cost
15P.	Bldg 1021, HW Generator A - Burner and burner controls	5.48	3.10	\$ 48,000
21.	Bldg 311 - Chillers	3.60	2.78	\$268,700
13P.	Bldg 745, Blr No. 5 - Flue gas monitoring equipment and oxygen trim in conjunction w/burner replacement	5.96	2.85	\$ 19,700
14P.	Bldg 745, Blr No. 5 - Economizer	5.95	2.53	\$ 70,100
16P.	Bldg 745, Blr No. 1 - Economizer	6.09	2.47	\$ 70,100
17P.	Bldg 745, Blr No. 4 - Economizer	6.16	2.45	\$ 70,100
18P.	Bldg 1021, HW Generator B - Burner and burner controls	5.74	2.95	\$ 48,000
19P.	Bldg 745, Blr No. 4 - Flue gas monitoring equipment and oxygen trim	6.50	2.61	\$ 19,700
20P.	Bldg 645, Blr No. 3 - Economizer	7.00	2.15	\$ 66,700
22.	Bldg 1021 - Chillers	8.03	1.25	\$232,100
23.	Bldg 2369 - Chillers	8.16	1.23	\$283,240
254*	Instrumentation for Bldg 311 Blrs	--	--	\$ 6,900
271*	Design Information	--	--	--

*ECO's that do not have tangible benefits, but would be advantageous if performed, are listed without calculations or a feasibility determination.

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TABLE II (Continued)

ENERGY CONSERVATION OPPORTUNITIES (ECO)
(These evaluations are based on Propane Fuel
and 1,110 Hours of Chiller Operation)

ECO	Description	SAP	SIR	Estimated Cost
272*	Monitor Boiler Efficiency	--	--	--
273*	Log Books	--	--	--
274*	Boiler Servicing	--	--	--
352*	Instrumentation for Bldg 645 Blrs	--	--	\$12,420
371*	Design Information	--	--	--
372*	Monitor Boiler Efficiency	--	--	--
373*	Log Books	--	--	--
374*	Boiler Servicing	--	--	--
375*	Boiler Loading	--	--	--
452*	Instrumentation for Bldg 745 Blrs	--	--	\$12,420
471*	Design Information	--	--	--
472*	Monitor Boiler Efficiency	--	--	--
473*	Log Books	--	--	--
474*	Boiler Servicing	--	--	--
475*	Boiler Loading	--	--	--
552*	Instrumentation for Bldg 1021, HW Gen Units	--	--	\$10,120
571*	Design Information	--	--	--

*ECO's that do not have tangible benefits, but would be advantageous if performed, are listed without calculations or a feasibility determination.

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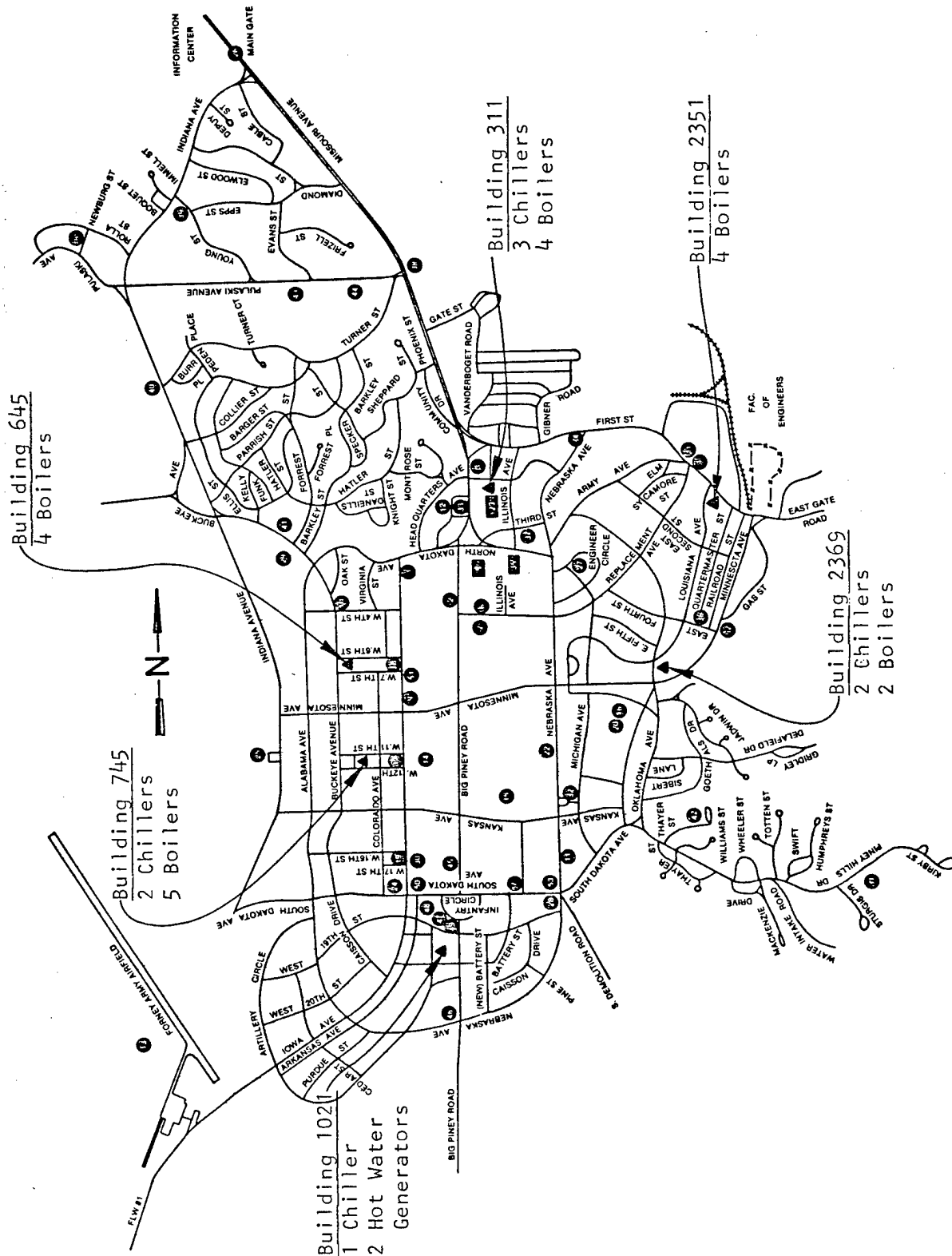
TABLE II (Continued)

ENERGY CONSERVATION OPPORTUNITIES (ECO)
(These evaluations are based on Propane Fuel
and 1,110 Hours of Chiller Operation)

ECO	Description	SAP	SIR	Estimated Cost
572*	Monitor Boiler Efficiency	--	--	--
573*	Log Books	--	--	--
574*	Boiler Servicing	--	--	--
662*	Insulation on Steam and Feedwater Piping for Bldg 2351	--	--	--
654*	Boiler Control, butterfly valve and linkage on gas train, Bldg 2351, Blrs 1 and 2	--	--	\$ 4,500
652*	Instrumentation for Bldg 2351 Blrs	--	--	\$ 1,380
671*	Design Information	--	--	--
672*	Monitor Boiler Efficiency	--	--	--
673*	Log Books	--	--	--
752*	Instrumentation for Bldg 2369, HW Gen Units	--	--	\$10,120
771*	Design Information	--	--	--
772*	Monitor Boiler Efficiency	--	--	--
773*	Log Books	--	--	--
774*	Boiler Servicing	--	--	--

*ECO's that do not have tangible benefits, but would be advantageous if performed, are listed without calculations or a feasibility determination.

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NOTE: See Table III for Equipment Descriptions.

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TABLE III

CHILLER AND BOILER TABULATION BY BUILDING

Building 311

Chiller No.	1	2	3
Manufacturer	York	Carrier	Carrier
Type	York Hermetic Turbopak	Centrifugal 19DK6174CM	Centrifugal 19DK6174CM
Model	HTM2G1-GAA		
Compressor Model	MKA 65		
Compressor Serial No.	EM-05855		
Manufacture Date	1975		
Nominal Tons	750	300	300

Building 745

Chiller No.	1	2
Manufacturer	Chrysler	Carrier
Type	Chrysler Air Temp Centrifugal	Hermetic Centrif- ugal Water Chiller
Model	C2SR989-2	19EA8273DL
Serial No.	5B112341	775226867
Manufacture Date	1975	1977
Nominal Tons	960	

Building 1021

Chiller No.	1
Manufacturer	Carrier
Type	Centrifugal Chiller
Model	19C860
Serial No.	690613472
Manufacture Date	1969
Nominal Tons	1050

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TABLE III (Continued)

CHILLER AND BOILER TABULATION BY BUILDING

Building 2369

Chiller No.	1	2	3
Manufacturer	York	York	
Type	Hermetic Turbopak Liquid Chilling Unit	Hermetic Turbopak Liquid Chilling Unit	
Model	HTN3GL-GBB	HTN3GL-GBB	
Compressor Serial No.	FM-091147	FM-091148	
Manufacture Date	1976	1976	
Nominal Tons	910	910	

Building 311

Boiler No.	1	2	3	4
Manufacturer	Kewanee	Kewanee	Titusville	Keeler
Type	Marine Type	Marine Type	Fire Tube	Water Tube
Year Built	1984	1984	1963	1963
Year Installed	1984	1984	1963	1963
Firing Equipment	Auto	Auto	Auto	Auto
Fuel	#6 oil	#6 oil	#6 oil	#6 oil
W/Pressure Design	150	150	125	200
Allowable Pressure	150	150	125	200
Safe/Valve Set	125	125	125	110/115
Serial No.	B4293	R4724	40838	15889
Heating Surface				
Boiler	1500	1500	Unknown	1735
Water Wall			Unknown	337
Output (Btu/hr)	10.043 million steam	10.043 million steam	7.17 million steam	10.75 million steam

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TABLE III (Continued)

CHILLER AND BOILER TABULATION BY BUILDING

Building 645

Boiler No.	1	2	3	4
Manufacturer	Keeler	Keeler	Keeler	Titusville
Type	Water Tube	Water Tube	Water Tube	Water Tube
Year Built	1959	1959	1959	1963
Year Installed	1959	1959	1959	1963
Firing Equipment	Auto	Auto	Auto	Auto
Fuel	#6 oil	#6 oil	#6 oil	#6 oil
W/Pressure Design	160	160	160	160
Allowable Pressure	160	160	160	160
Safe/Valve Set	135/140	135/140	135/140	135/140
Serial No.	13500	13501-1	13501-2	40883
Heating Surface				
Boiler	1275	2648	2648	2642
Water Wall	275	422	422	432
Output (Btu/hr)	10.7 million steam	21.5 million steam	21.5 million steam	21.5 million steam

Building 745

Boiler No.	1	2	3	4
Manufacturer	Erie City	Erie City	Erie City	Erie City
Type	Water Tube	Water Tube	Water Tube	Water Tube
Year Built	1965	1963	1964	1966
Year Installed	1965	1963	1964	1966
Firing Equipment	Auto	Auto	Auto	Auto
Fuel	#6 oil	#6 oil	#6 oil	#6 oil
W/Pressure Design	160	160	160	160
Allowable Pressure	160	160	160	160
Safe/Valve Set	134/141/144	138/141	135/140	130/135/140
Serial No.	1778	1521	1520	1779
Heating Surface				
Boiler	Unknown	Unknown	Unknown	Unknown
Water Wall	Unknown	Unknown	Unknown	Unknown
Output (Btu/hr)	29 million steam	19.9 million steam	19.9 million steam	29 million steam

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TABLE III (Continued)

CHILLER AND BOILER TABULATION BY BUILDING

Building 745, Continued

Boiler No.	<u>5</u>
Manufacturer	Erie City
Type	Water Tube
Year Built	1966
Year Installed	1966
Firing Equipment	Auto
Fuel	#6 oil
W/Pressure Design	160
Allowable Pressure	160
Safe/Valve Set	130/135/140
Serial No.	1780
Heating Surface	
Boiler	Unknown
Water Wall	Unknown
Output (Btu/hr)	29 million

Building 1021

Hot Water Generator	<u>A</u>	<u>B</u>
Manufacturer	Flo-Kontrol	Flo-Kontrol
Type	Water Tube	Water Tube
Year Built	1969	1969
Year Installed	1969	1969
Firing Equipment	Auto	Auto
Fuel	#6 oil	#6 oil
W/Pressure Design	500	500
Allowable Pressure	500	500
Safe/Valve Set		
Serial No.	186	187
Heating Surface		
Total	5500	5500
Output (Btu/hr)	46,000,000	46,000,000

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TABLE III (Continued)

CHILLER AND BOILER TABULATION BY BUILDING

Building 2351

Boiler No.	1	2	3	4
Manufacturer	Bigelow	Bigelow	Cleaver Brooks	Cleaver Brooks
Type	Water Tube	Water Tube	Fire Tube	Fire Tube
Year Built	1966	1966	1972	1972
Year Installed	1966	1966	1972	1972
Firing Equipment	Auto	Auto	Auto	Auto
Fuel	LP gas	LP gas	#2 oil	#2 oil
W/Pressure Design	160	160	200	200
Allowable Pressure	160	160	200	200
Safe/Valve Set	140/145	140/145	125	125
Serial No.	12734	12734	L-55457	L-55458
Heating Surface				
Boiler	2280	2280	Unknown	Unknown
Water Wall	326	326	Unknown	Unknown
Output (Btu/hr)	17.2 million steam	17.2 million steam	14.8 million steam	14.8 million steam

Building 2369

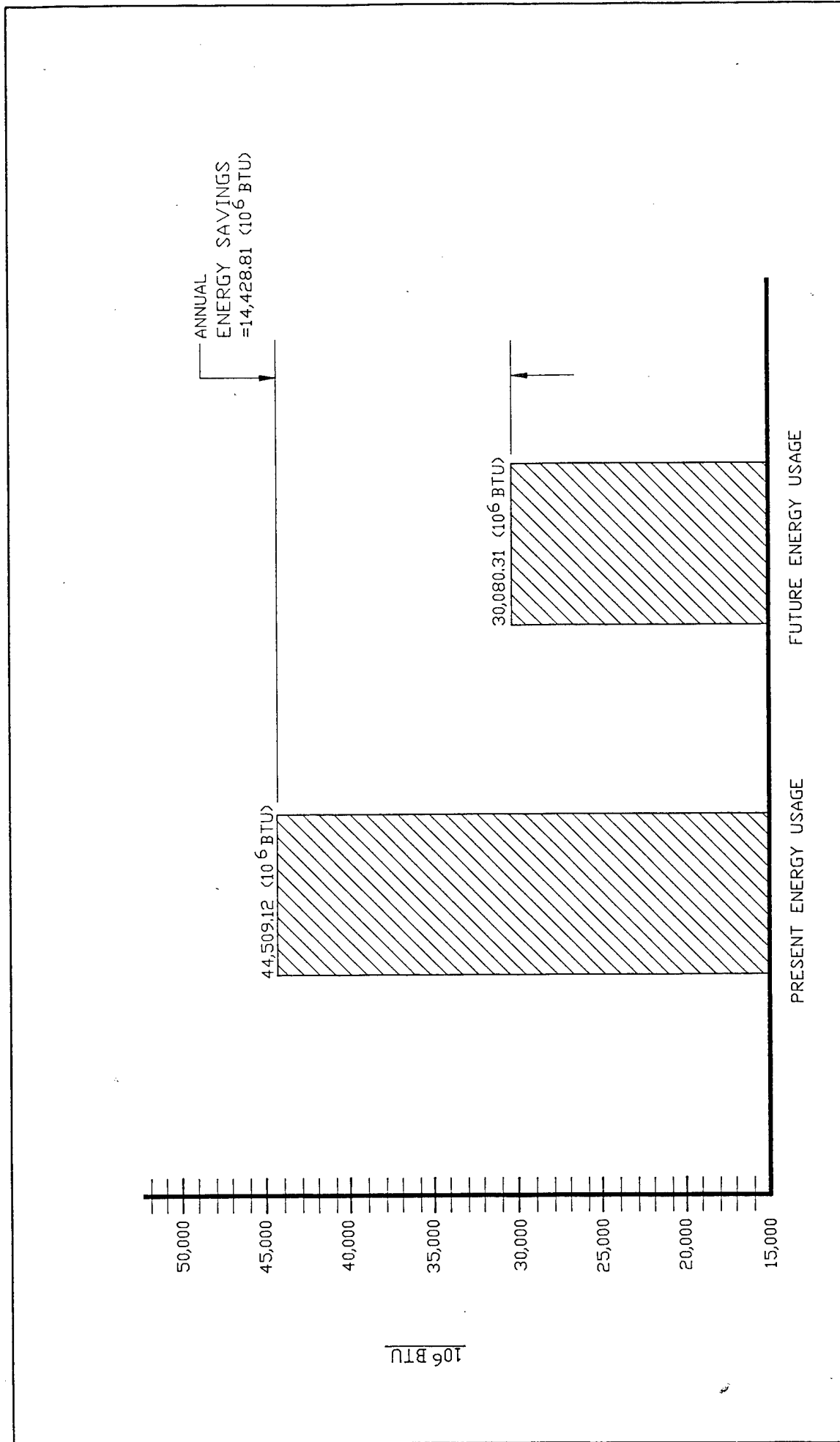
Boiler No.	1	2
Manufacturer	International	International
Type	Water Tube	Water Tube
Year Built	1976	1976
Year Installed	1976	1976
Firing Equipment	Auto	Auto
Fuel	#6 oil	#6 oil
W/Pressure Design	500	500
Allowable Pressure	500	500
Safe/Valve Set	412	412
Serial No.	14680	14679
Heating Surface		
Boiler	2182	2182
Water Wall	328	328
Output (Btu/hr)	24 million HTW	24 million HTW

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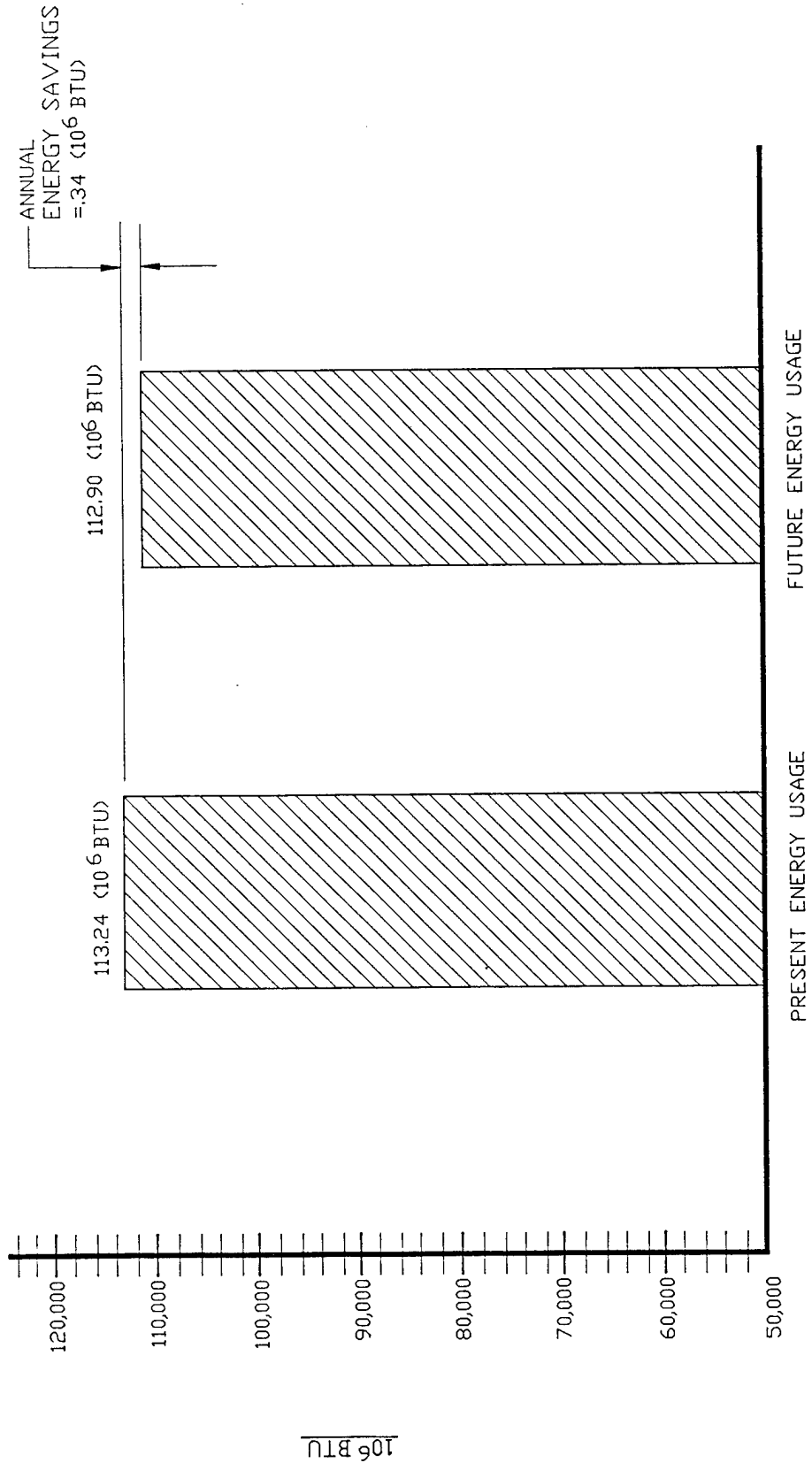
TABLE IV

PERCENT ENERGY SAVINGS POSSIBLE AFTER
FEASIBLE ECO IMPLEMENTATION

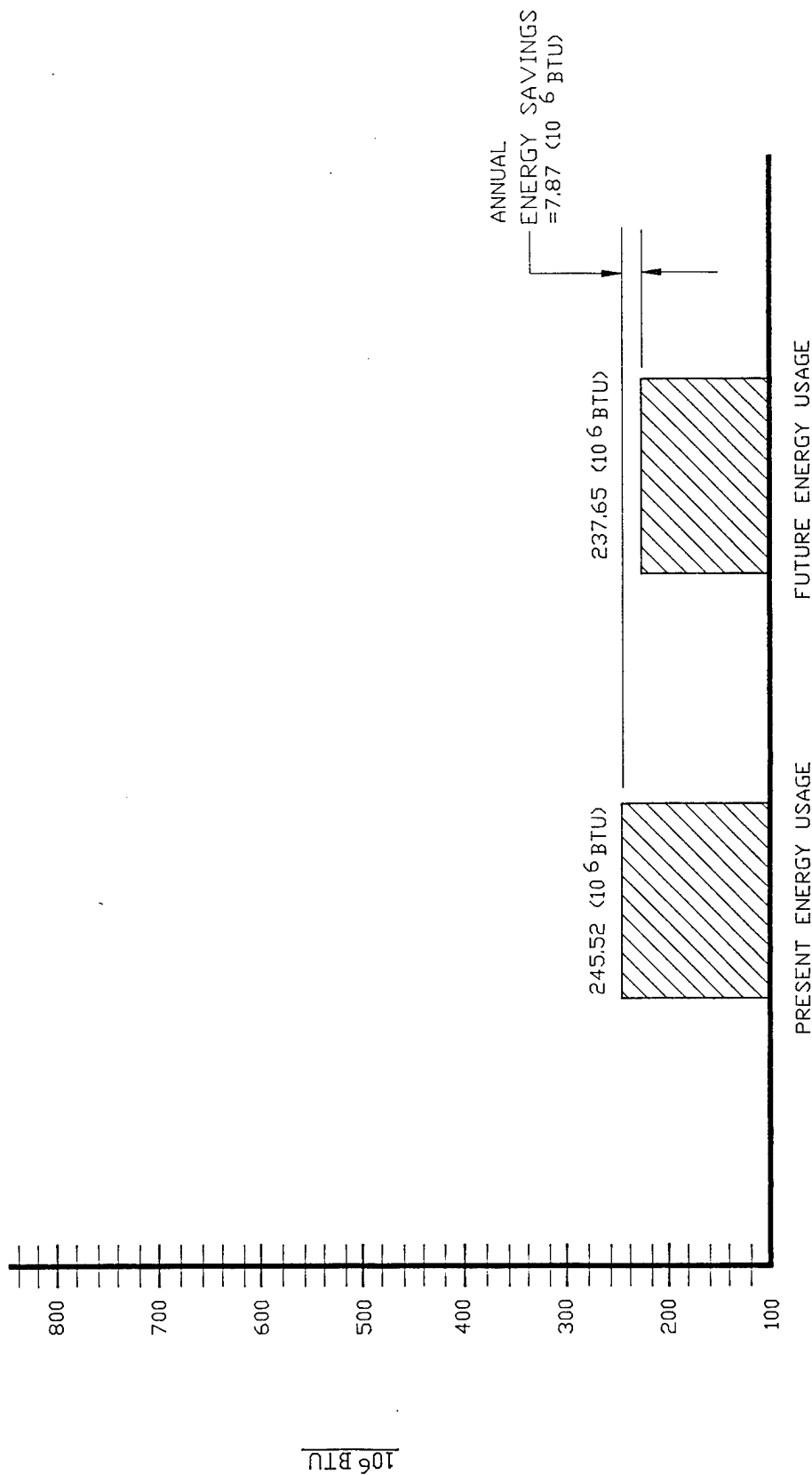
<u>Building/Equipment</u>	<u>Savings, %</u>
All/All	32
311/Boilers	0.30
645/Boilers	3.2
745/Boilers	3.3
1021/Boilers	2.8
All/Chillers	33



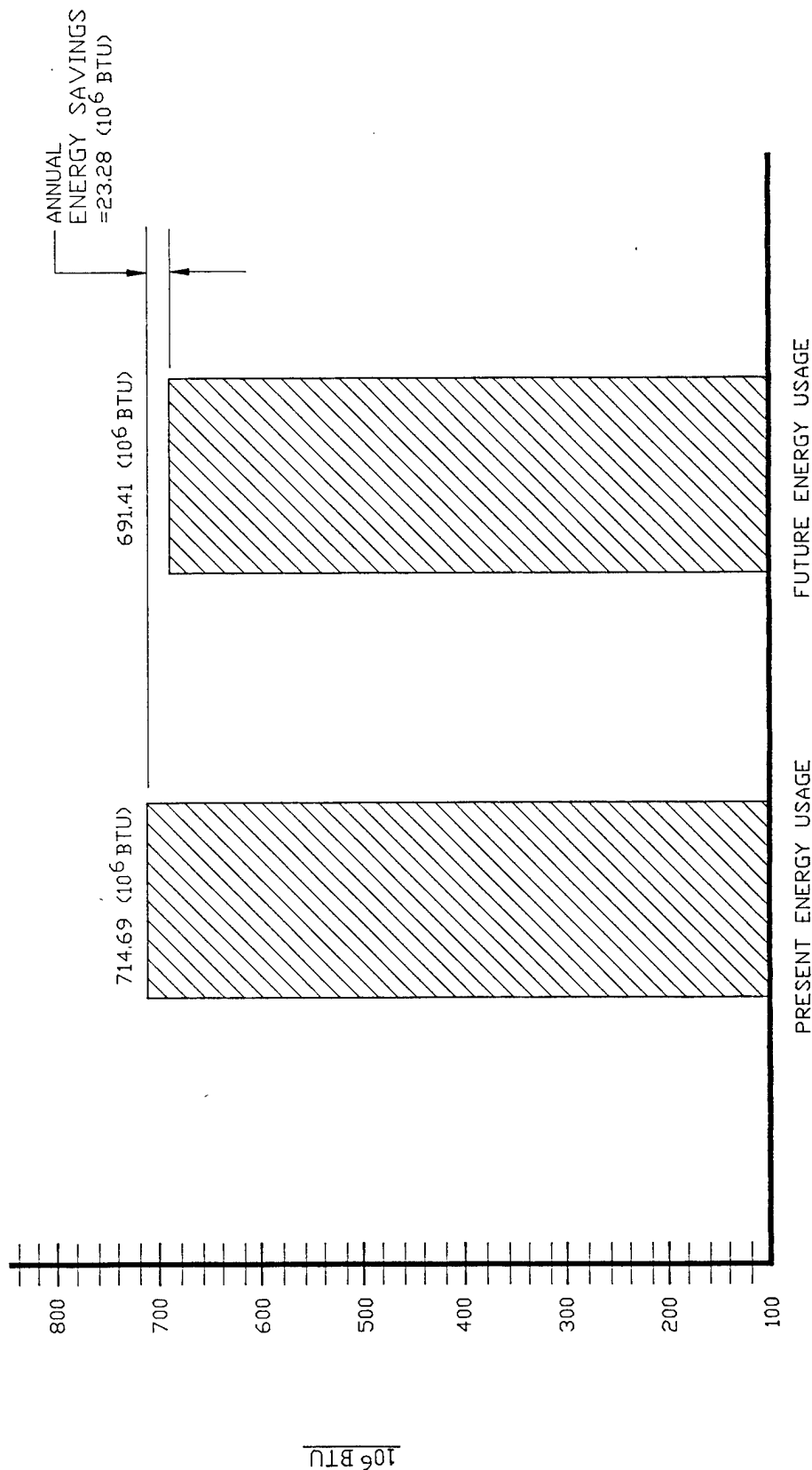
REV.	DESCRIPTION	DESIGN BY	CHECKED BY	APPROVED BY	FT. LEONARD WOOD BOILER/CHILLER EEAP STUDY CONTRACT NO. DACA41-86-C-0015	SUM OF ALL FEASIBLE ECD'S ANNUAL ENERGY SAVINGS	FIG. NO. 1
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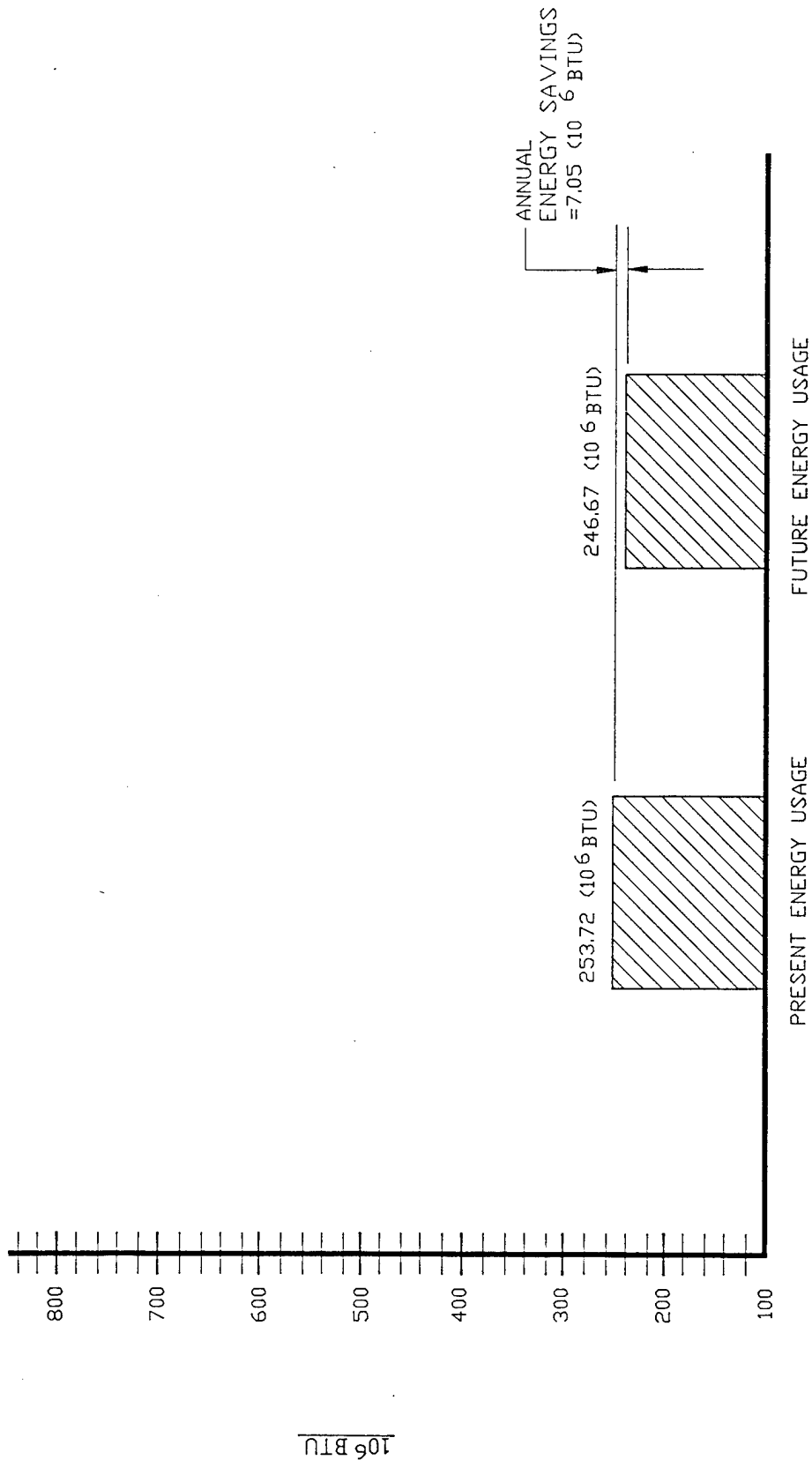
REV.	DESCRIPTION	DESIGN BY	DRAWN BY	CHECKED BY	APPROVED BY	LUTZ, DAILY & BRAIN CONSULTING ENGINEERS SHAWNEE MISSION, KANSAS 66201 P.O. BOX 718	FT. LEONARD WOOD BOILER/CHILLER EEAP STUDY CONTRACT NO. DACA41-86-C-0015	BUILDING 311 BOILER FEASIBLE ECO'S (EXCLUDING CHILLERS)	FIG. NO. 2	FLWGR
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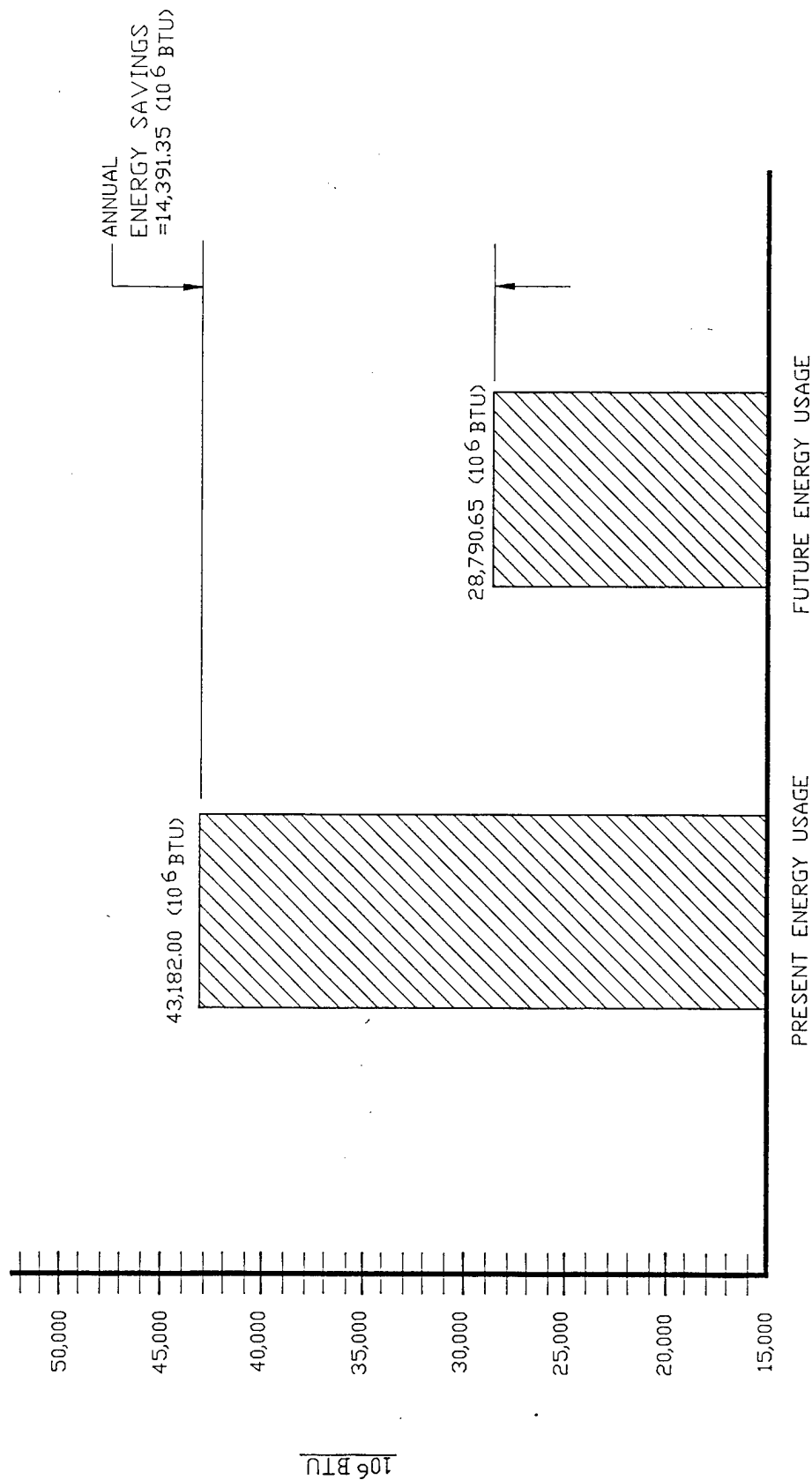
REV.	DESCRIPTION	DESIGN BY _____ DRAWN BY _____	 LUTZ, DAILY & BRAIN CONSULTING ENGINEERS P.O. BOX 716 SHAWNEE MISSION, KANSAS 66201	FT. LEONARD WOOD BOILER/CHILLER EEAP STUDY CONTRACT NO. DACA41-86-C-0015	BUILDING 645 BOILER FEASIBLE ECO'S	FIG. NO. 3



REV.	DESCRIPTION	DESIGN BY	DRAWN BY	CHECKED BY	APPROVED BY	FT. LEONARD WOOD BOILER/CHILLER EEAP STUDY CONTRACT NO. DACA41-86-C-0015	BUILDING 745 BOILER FEASIBLE ECO'S (EXCLUDING CHILLERS)	FIG. NO. 4
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REV.	DESCRIPTION	DESIGN BY _____ DRAWN BY _____	CHECKED BY _____ APPROVED BY _____	LUTZ, DAILY & BRAIN CONSULTING ENGINEERS P.O. BOX 718 SHAWNEE MISSION, KANSAS 66201	FT. LEONARD WOOD BOILER/CHILLER EEAP STUDY CONTRACT NO. DACA41-86-C-0015	BUILDING 1021 BOILER FEASIBLE ECD'S (EXCLUDING CHILLER)	FIG. NO. 5
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REV.

DESCRIPTION

DESIGN BY

DRAWN BY

CHECKED BY

APPROVED BY

LUTZ, DAILY & BRAIN CONSULTING ENGINEERS
P.O. BOX 718 SHAWNEE MISSION, KANSAS 66201

FT. LEONARD WOOD
BOILER/CHILLER EEAP STUDY
CONTRACT NO. DACA41-86-C-0015

SUM OF ALL CHILLER &
CHILLER DDC FEASIBLE
ECO'S

FIG. NO.

6

B. CONCLUSION

1. Boiler Inspections

Inspection of the boilers within the scope of this study indicates that the boilers are in satisfactory condition. With recommended repairs and proper maintenance and operation all boilers should last at least an additional ten years.

The boiler controls for all boilers in Building 745 are obsolete. Oxygen monitoring equipment has recently been outdated by new monitoring equipment which has entered the market in recent years. Existing monitoring equipment is not maintained because of soot plugging problems and a tendency of the Base to operate with high excess air. The temperature transmitters are also outdated and the flow transmitters are inaccurate. The Corps of Engineers has already replaced the boiler controls on the five boilers in Building 745 (Solicitation No. DACA41-87-B-1327).

It is recommended that outdated boiler controls, instruments and monitoring equipment be replaced.

2. Boiler Performance Testing

Performance testing of the boilers shows that there is a considerable amount of savings possible by reducing the excess air and flue gas temperatures in the operation of the boilers. The performance test units and the boiler descriptions are summarized in Table 1-6, Unit Description and Test Results Summary, in Volume 1 - Summary.

3. Boiler Recommendations

It is recommended that action be taken to reduce the amount of excess air used in the operation of the boilers as follows:

- a. Install new oxygen and combustible monitoring equipment with oxygen trim.

Building 311 - Portable flue gas analyzer (only).

Building 645 - Boiler No. 3

Building 745 - Boiler No. 1
Boiler No. 4
Boiler No. 5

Building 1021 - Hot Water (HW) Generator A
HW Generator B

Building 2369 - HW Generator A
HW Generator B

- b. Install new burner and controls.

Building 645 - Boiler No. 1

Building 745 - Boiler No. 1
Boiler No. 4
Boiler No. 5

Building 1021 - HW Generator A
HW Generator B

- c. Complete overhaul of boiler controls - all boilers.

- d. Biannual boiler control servicing - all boilers.

It is recommended that economizers be installed to reduce the exit flue gas temperature on the following boilers.

Building 645 - Boiler No. 1

Building 745 - Boiler No. 1
Boiler No. 4
Boiler No. 5

Building 2351 - Boiler No. 1
Boiler No. 2

Building 2369 - HW Generator A
HW Generator B

We also recommend the following improvements:

- a. New instrumentation should be installed to allow the boiler performances to be monitored.
- b. Give strict attention to updating and maintaining design information for existing and future systems and equipment.
- c. Log books should be kept to record equipment maintenance and modification.

Performance testing has revealed poor burner characteristics in the Building 1021 hot water generators. These Building 1021 burners are misapplied and it is recommended that they be replaced. The burners are oversized for the loading requirements and have poor turndown characteristics. (See Volume 5 for additional information and explanation.)

It is recommended that the Operations and Maintenance personnel involved in the operation of the boilers attend Boiler Efficiency Improvement Classes. One source of this type of training is presented about every two years in St. Louis, Missouri by David F. Dyer and

Glennon Maples who are Professors of Mechanical Engineering at Auburn University in Auburn, Alabama. The enrollment fee for this class is \$400 per student. Another alternative would be to have the instructors mentioned above conduct their class at the Fort Leonard Wood Base. The cost for this is \$500 per day plus expenses. With their permission, portions of their Boiler Efficiency Improvement Study have been included in this report.

4. Chillers

The existing chillers in Buildings 311, 1021 and 2369 were originally designed to operate at efficiencies of 0.8 kw per ton of refrigeration. The auxiliary equipment normally used 0.2 kw per ton of refrigeration. The existing chillers were tested under various load conditions during our field activities. The test results indicated the existing chillers are operating at efficiencies ranging from 1.2 kw per nominal ton of refrigeration for chillers in Building 1021 to 1.59 kw per nominal ton of refrigeration for chillers in Building 311. Operating hours for each chiller were obtained from the Base engineering personnel for each chiller. New state-of-art centrifugal chillers are now designed to operate at 0.62 kw per nominal ton of refrigeration for this size of chillers. ECO's have been prepared for replacement of the existing chillers with new chillers. The results of each ECO indicate substantial energy savings could be realized if the ECO's are incorporated. The result of each ECO is summarized in tabular form in Volume I of this report. The following ECO's are recommended:

ECO 21 Replacement High Efficiency Chillers Bldg 311.

ECO 22 Replacement High Efficiency Chillers Bldg 1021.

ECO 23 Replacement High Efficiency Chillers Bldg 2369.

The existing chiller plants at Fort Leonard Wood operate through manual control methods. The operators start and stop the chillers, make hourly, daily and weekly adjustments to operations, and generally supervise all operations of the equipment.

The adjustments to the chillers such as which chiller should operate, chilled water supply temperatures, and when a second or third chiller should be energized are made by the operators based on existing chilled water demand and projected chilled water demand. Direct Digital Control (DDC) systems are very effective when used in multiple chiller plants. The DDC systems operate individual chillers, sequence chiller operations for multiple chiller plants, and energize associated pumps and cooling towers. The chilled water and condenser water temperatures and pressures are monitored and evaluated by the DDC and used to determine which chiller should operate, when the chiller should operate and how long the chiller should operate. The chiller operation will be in response to the individual system load characteristics. Control features include chilled water reset, low load

control, equipment sequencing, lead/lag control, cooling tower temperature control, soft loading and kw demand limiting. All of these features result in a significant energy savings for the multiple chiller plants. The results of the individual ECO's are included in Volume I tables. The following ECO's are recommended:

ECO 1 Energy Management System, DDC for Bldg 1021 Chillers.

ECO 4 Energy Management System, DDC for Bldg 2369 Chillers.

ECO 6 Energy Management System, DDC for Bldg 311 Chillers.

ECO 12 Energy Management System, DDC for Bldg 745 Chillers.

5. Life Cycle Cost Analyses

Appendix A includes the Life Cycle Cost Summary data for each individual ECO and for the ECO groupings.

APPENDIX A
LIFE CYCLE COST DATA

The following seven (7) pages are the Life Cycle Summary data for the project ECO groupings.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____
PROJECT TITLE New Burner & Burner Controls (ECIP) FISCAL YEAR _____
DISCRETE PORTION NAME ECO Nos. 7P, 9P, 10P, 11P, 15P, 18P
ANALYSIS DATE 12-12-88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$ 490,000
B. SIOH (5 1/2 %)	\$ 26,950
C. DESIGN COST (6%)	\$ 29,400
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$ 491,715
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$ 0
	\$ 491,715

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$ _____	_____	\$ _____	_____	\$ _____
B. DIST	\$ _____	_____	\$ _____	_____	\$ _____
C. RESID	\$ _____	_____	\$ _____	_____	\$ _____
D. PROPANE	\$ 3.76	20,357	\$ 76,522	16.95	\$1,297,049
E. COAL	\$ _____	_____	\$ _____	_____	\$ _____
F. TOTAL		20,357	\$ 76,522		-----> \$1,297,049

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) \$ _____
 (1) DISCOUNT FACTOR (TABLE A) _____
 (2) DISCOUNTED SAVING/COST (3A X 3A1) \$ _____

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)/COST(-)(4)
a. _____	\$ _____	_____	_____	\$ _____
b. _____	\$ _____	_____	_____	\$ _____
c. _____	\$ _____	_____	_____	\$ _____
d. TOTAL	\$ _____			\$ _____

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$ _____

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ _____

a IF 3D1 IS = OR > 3C GO TO ITEM 4

b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F= _____

c IF 3D1b = > 1 GO TO ITEM 4

d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 76,522

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$1,297,049

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 3.20

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____

PROJECT TITLE Economizer (ECIP) FISCAL YEAR _____

DISCRETE PORTION NAME ECO Nos. 14P, 16P, 17P, 20P

ANALYSIS DATE 12-12-88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$	333,000
B. SIOH (5 1/2 %)	\$	18,315
C. DESIGN COST (6)	\$	19,980
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	371,295
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$	0
		\$ 371,295

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$		\$		\$
B. DIST	\$		\$		\$
C. RESID	\$		\$		\$
D. PROPANE	\$ 3.76	11,763	\$ 44,217	16.95	\$ 749,478
E. COAL	\$		\$		\$
F. TOTAL		11,763	\$ 44,217		-----> \$ 749,478

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) _____

(2) DISCOUNTED SAVING/COST (3A X 3A1) _____

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(-)(4)
a. _____	\$			\$
b. _____	\$			\$
c. _____	\$			\$
d. TOTAL	\$			\$

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$ _____

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ _____

a IF 3D1 IS = OR > 3C GO TO ITEM 4

b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F= _____

c IF 3D1b = > 1 GO TO ITEM 4

d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 44,217

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 749,478

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 2.72

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____

PROJECT TITLE New Chillers (ECIP) FISCAL YEAR _____

DISCRETE PORTION NAME ECO Nos. 21, 22, 23

ANALYSIS DATE 2/12/88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$ 943,000
B. SIOH (5 1/2 %)	\$ 51,865
C. DESIGN COST (6%)	\$ 56,580
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$1,051,445
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$ 0
	<u>\$ 1,051,445</u>

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$ 13.98	10,292	\$ 143,882	10.02	\$1,441,697
B. DIST	\$		\$		\$
C. RESID	\$		\$		\$
D. PROPANE	\$		\$		\$
E. COAL	\$		\$		\$
F. TOTAL		10,292	\$ 143,882	----->	<u>\$1,441,697</u>

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)	\$
(1) DISCOUNT FACTOR (TABLE A)	
(2) DISCOUNTED SAVING/COST (3A X 3A1)	\$

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(-)(4)
a. _____	\$			\$
b. _____	\$			\$
c. _____	\$			\$
d. TOTAL	\$			\$

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$

D. PROJECT NON ENERGY QUALIFICATION TEST

- (1) 25% MAX NON ENERGY CALC (2F5 X .33) \$
- a IF 3D1 IS = OR > 3C GO TO ITEM 4
- b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F=
- c IF 3D1b = > 1 GO TO ITEM 4
- d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 143,882

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$1,441,697

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 1.85

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____
PROJECT TITLE Chiller Direct Digital Control System (QRIP) FISCAL YEAR _____
DISCRETE PORTION NAME ECO Nos. 1, 6, 4, 12
ANALYSIS DATE 12-12-88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$	132,270
B. SIOH	\$	0
C. DESIGN COST	\$	0
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	119,043
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$	0
		\$ 119,043

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$ 13.98	6,000	\$ 83,880	10.02	\$ 840,478
B. DIST	\$ _____	_____	\$ _____	_____	\$ _____
C. RESID	\$ _____	_____	\$ _____	_____	\$ _____
D. NG	\$ _____	_____	\$ _____	_____	\$ _____
E. COAL	\$ _____	_____	\$ _____	_____	\$ _____
F. TOTAL		6,000	\$ 83,880	----->	\$ 840,478

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) _____ \$ _____

(2) DISCOUNTED SAVING/COST (3A X 3A1) _____ \$ _____

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(-)(4)
a. _____	\$ _____	_____	_____	\$ _____
b. _____	\$ _____	_____	_____	\$ _____
c. _____	\$ _____	_____	_____	\$ _____
d. TOTAL	\$ _____			\$ _____

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$ _____

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ _____

a IF 3D1 IS = OR > 3C GO TO ITEM 4

b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F= _____

c IF 3D1b = > 1 GO TO ITEM 4

d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 83,880

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 840,478

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 6.35

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____

PROJECT TITLE Flue Gas Analyzer FISCAL YEAR _____

DISCRETE PORTION NAME ECO No. 2P

ANALYSIS DATE 12-12-88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$	3,400	
B. SIOH	\$	0	
C. DESIGN COST	\$	0	
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	3,060	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$	0	
			\$ 3,060

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$ _____	_____	\$ _____	_____	\$ _____
B. DIST	\$ _____	_____	\$ _____	_____	\$ _____
C. RESID	\$ _____	_____	\$ _____	_____	\$ _____
D. PROPANE	\$ 3.76	333	\$ 1,252	16.95	\$ 21,221
E. COAL	\$ _____	_____	\$ _____	_____	\$ _____
F. TOTAL		333	\$ 1,252	----->	\$ 21,221

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) _____

(2) DISCOUNTED SAVING/COST (3A X 3A1) _____

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(-)(4)
a. _____	\$ _____	_____	_____	\$ _____
b. _____	\$ _____	_____	_____	\$ _____
c. _____	\$ _____	_____	_____	\$ _____
d. TOTAL	\$ _____			\$ _____

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$ _____

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ _____

a IF 3D1 IS = OR > 3C GO TO ITEM 4

b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F= _____

c IF 3D1b = > 1 GO TO ITEM 4

d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 1,252

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 21,221

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 6.28

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____
PROJECT TITLE Flue Gas Monitoring Equipment & Oxygen Trim FISCAL YEAR _____
with Burner Replacement

DISCRETE PORTION NAME ECO Nos. 3P, 5P, 8P, 13P, 24P

ANALYSIS DATE 12-12-88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$	98,500	
B. SIOH	\$	0	
C. DESIGN COST	\$	0	
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	88,650	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$	0	
			\$ 88,650

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$		\$		\$
B. DIST	\$		\$		\$
C. RESID	\$		\$		\$
D. PROPANE	\$ 3.76	5,008	\$ 18,826	16.95	\$ 319,101
E. COAL	\$		\$		\$
F. TOTAL		5,008	\$ 18,826		-----> \$ 319,101

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) \$ _____
 (1) DISCOUNT FACTOR (TABLE A)
 (2) DISCOUNTED SAVING/COST (3A X 3A1) \$ _____

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(-)(4)
a. _____	\$ _____			\$ _____
b. _____	\$ _____			\$ _____
c. _____	\$ _____			\$ _____
d. TOTAL	\$ _____			\$ _____

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$ _____

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ _____

a IF 3D1 IS = OR > 3C GO TO ITEM 4

b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F= _____

c IF 3D1b = > 1 GO TO ITEM 4

d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 18,826

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 319,101

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 3.26

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Leonard Wood, Missouri REGION NO. _____ PROJECT NUMBER _____

PROJECT TITLE Flue Gas Monitoring Equipment and Oxygen Trim (LC/NC) FISCAL YEAR _____

DISCRETE PORTION NAME ECO No. 19P

ANALYSIS DATE 12-12-88 ECONOMIC LIFE 20 YEARS PREPARED BY TFL

1. INVESTMENT

A. CONSTRUCTION COST	\$	19,700	
B. SIOH	\$	0	
C. DESIGN COST	\$	0	
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	17,730	
E. SALVAGE VALUE OF EXISTING EQUIPMENT	-\$	0	
			\$ 17,730

2. ENERGY SAVINGS (+) / COST (-)

ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	COST \$/MMBTU(1)	SAVINGS MMBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$		\$		\$
B. DIST	\$		\$		\$
C. RESID	\$		\$		\$
D. PROPANE	\$ 3.76	806	\$ 3,030	16.95	\$ 51,359
E. COAL	\$		\$		\$
F. TOTAL		806	\$ 3,030		-----> \$ 51,359

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)

(1) DISCOUNT FACTOR (TABLE A) _____

(2) DISCOUNTED SAVING/COST (3A X 3A1) _____

B. NON RECURRING SAVINGS (+) / COST(-)

ITEM	SAVINGS(+) COST(-)(1)	YEAR OF OC- CURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV- INGS(+)COST(-)(4)
a. _____	\$			\$
b. _____	\$			\$
c. _____	\$			\$
d. TOTAL	\$			\$

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+) / COST (-) (3A2+3Bd4) \$ _____

D. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC (2F5 X .33) \$ _____

a IF 3D1 IS = OR > 3C GO TO ITEM 4

b IF 3D1 IS < 3C CALC SIR = (2F5+3D1) / 1F= _____

c IF 3D1b = > 1 GO TO ITEM 4

d IF 3D1b IS < 1 PROJECT DOES NOT QUALITY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1d / YEARS ECONOMIC LIFE) \$ 3,030

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) \$ 51,359

6. DISCOUNTED SAVINGS RATIO (IF < 1 PROJECT DOES NOT QUALITY)(SIR)=(5 / 1F)= 2.63